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MINERALS OF THE SALINE DOMES OF THE TEXAS-LOUISIANA COASTAL PLAIN

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The greater number of our most interesting mineral occurrences would remain unknown to us were it not for their close connection with ore deposits or other materials of economic importance. Even the oil fields in the topographically almost featureless plain bordering the Gulf of Mexico are found to be by no means wholly lacking in things of interest to the mineralogist.

Years ago the drilling of deep wells near the Texas-Louisiana coast, at places where there were gas seeps, sulfurous springs, or salt licks, led to the discovery of petroleum in that region. The gradual extension of these oil fields and the discovery of others has greatly broadened our knowledge concerning the geology and mineralogy of the rocks associated with them. It has been found that the oil deposits seem to be invariably associated in this coastal plain region with what are known as saline domes.

The saline domes are usually wholly subterranean and buried from sight under the nearly horizontally bedded sands and clays of the plain. Rarely they are marked by low mounds, whose summits in some cases are 60 or 80 feet above the surrounding country and have a diameter of a mile or more. At other times their location is marked by a depression filled by a lake. Usually they are invisible to the eye and some of them are beneath the waters of the Gulf of Mexico. Some 63 such domes have been mapped to date in Texas and Louisiana alone, and others yet undiscovered doubtless exist there. Further south, in the Yucatan Peninsula of Mexico, other similar domes are also yielding large quantities of oil.

Saline domes are well known in other parts of the world.

Their general characteristic is the presence within them of large deposits of mineral salts of various kinds, principally sulfates and chlorides of sodium and potassium. The domes of Germany have supplied vast quantities of potassium salts, as well as of sodium salts, particularly halite. The deposits in the Texas-Louisiana region do not contain potassium salts, but are made up primarily of halite containing impurities in the form of other minerals in very minor amount.

The bottom of the salt deposits in Texas and Louisiana has never been found, tho borings have pierced rock salt for depths of 5,000 feet. The total thickness of the salt may be several times that figure. The upper part of the "salt core" is often conical and is usually mixed with layers or masses of gypsum and anhydrite, known to the drillers simply as "gypsum," and sometimes as "salt." Above this, usually not many hundreds of feet below ground, there is often a so-called "cap-rock" layer of hard but porous limestone or dolomite. In the numerous cavities of the latter rock large quantities of native sulfur are sometimes present, and petroleum is found in it or among the upturned sedimentary strata along the sides of the salt core.

The "gypsum" found in the Gulf Coast saline domes appears to be usually a very interesting combination of calcium sulfate in its anhydrous and hydrous forms. Abundant microscopic anhydrite crystals, without definite orientation or arrangement, are enclosed in a matrix of gypsum (selenite), whose crystals have cleavage directions in parallel position thruout the specimen. In other samples the material is massive, like fine-grained marble or alabaster, filled with bright anhydrite. This arrangement of the above minerals has been observed to be general in samples obtained from borings at Damon Mound, Hoskins Mound, and Pierce Junction, Texas. The anhydrite crystals are simple combinations of the three orthorhombic pinacoids, except for a few which have the form of steep pyramids. Two specimens of the "gypsum" from Damon Mound gave specific gravities of 2.37 and 2.88, respectively; the first is a specimen with pronounced cleavage in three directions; the second is very fine-grained granular, with massive structure. From this determination it is seen that the first specimen contains about 8.6 per cent. of anhydrite and 91.4 per cent. of gypsum, while the second has 97.2 per cent. of anhydrite and 2.8 per cent. of gypsum. Thus the cleavage of the first type is accounted for by the predominance of crystallized gypsum, which is present only in small quantity in the second, or massive, type of material.

The principal cleavage has, in some cases at least, been observed in a vertical position, indicating forces of crystallization operating in that direction.

Great numbers of small anhydrite crystals also occur embedded in the rock salt. They can be freed from the matrix of salt or of gypsum by treating the material with water in the former case or with a weak solution of hydrochloric acid in the latter. In either case the anhydrite crystals will be slightly etched and roughened by this treatment and some of their edges and corners will be rounded. From the gypsum of Damon Mound small doubly terminated quartz crystals were obtained. These are well developed, brilliant, and colorless to smoky. There are also some very clean-cut little dolomite rhombohedrons.

The sulfur that is present is often well crystallized, tho most of the crystals are small. Attractive box mounts are available. The two principal sulfur deposits now being worked commercially are at Sulphur station, Louisiana, west of New Orleans, and at Bryan Heights (Freeport), Texas, at the mouth of the Brazos River. The sulfur is obtained by forcing very hot water down the well casing into the heart of the deposit; the sulfur is melted and flows to the surface along a smaller pipe within the casing.

Sulfides in crystallized form have been reported from the salt mines of Louisiana; these are galenite, sphalerite, and pyrite. Some microscopic black crystals from the rock salt at Hockley, Texas, have been determined for the writer by Dr. Edgar T. Wherry as pseudomorphs of limonite after pyrite, the following forms having been identified:

Dominant form, 120, the usual pyritohedron; present in good-sized faces, 210, the negative pyritohedron; also 100, the cube. Other forms are represented by small and curved faces, but the form 340 was certainly identified, and forms 014, 016, and 067 doubtfully. No faces of the octahedron, 111, nor any diploids, were observed.

The surface clays above some of the salt domes, as at Damon Mound, are filled locally with tiny gypsum crystals and plates. There are also developments of sulfates of iron (partly melanterite) which in water solution have been extensively sold for medicinal purposes. In the borings from within the domes, pseudomorphs of calcite after selenite crystals have been reported, as well as some very nice little free selenites, some of which are twinned. One or two twinned calcite crystals 0.5 cm. long were also obtained, rhombohedrons completely filled with white sand after the manner of those from Fontainebleau. Much of the gypsum from the borings has a dark smoky color and upon breaking emits a strong fetid odor.

The rock salt is extensively mined in Louisiana at Weeks Island and elsewhere by means of large underground chambers. The most of the salt is of the familiar granular crystalline sort with but little impurity.

Specimens of old borings, consisting of gypsum and anhydrite, are available at some places (Damon Mound, Texas, being one of them). Under the present war conditions it is often difficult to obtain access to the sulfur properties or the mines.

LAZULITE IN AN UNUSUAL FORM

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Some months ago there was received at the National Museum for identification a peculiar rock, evidently a somewhat altered volcanic breccia, so injected with a blue coloring matter as to suggest lapis-lazuli. The manner in which the coloring matter was distributed, a portion of it in the cementing material and a portion actually replacing the original rock fragments, suggested its secondary origin and invited careful tests to ascertain its true nature. Thin sections under the microscope showed the coloring matter to occur as minute scales without crystal form and very irregularly distributed. These had the refractive indices and gave the chemical reactions of *lazulite,* which is a hydrous phosphate of aluminium, iron and magnesium. It is an interesting occurrence since it closely simulates, as above noted, lapis-lazuli (lazurite), which has, however, a quite different composition.

The specimen was received from Mr. Frederick L. Whitehead, of Hassel, Montana, who reports that he has found the material, thus far, only as float.

A LABORATORY METHOD OF TEACHING ELEMENTARY CRYSTALLOGRAPHY

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(*Continued from page 182*)

DIRECTIONS FOR DETERMINING THE AXIAL-RATIOS OF MODELS AND CRYSTALS

Outside of the Isometric System, the relative lengths of the crystallographic axes must be determined.

I. TETRAGONAL SYSTEM

Length of a-axis is 1; of b-axis is 1; of c-axis is to be determined.

(1) Draw a plan of the b- and c-axes on cross-section paper. Label these axes and indicate with heavy dots *unity* and *multiples of unity* on the b-axis. The unit length on this axis should include 10 or 20 or 30 small divisions of the cross-section paper.

(2) *Center* the model or crystal over the cross-section paper so that it is *oriented* in respect to the plan of the axes drawn on the latter.

(3) Select a face that cuts *both* the b- and c-axis. If more than one face does this, select the most prominent. The inclination of this face, then, determines the length of the c-axis. Project the inclination of this face onto the paper, lay your pencil parallel to the line so obtained, and roll the pencil until it coincides with *unity* on the b-axis; then the pencil cuts the c-axis also at *unity*, which is read off and recorded as a *decimal fraction.*

Note 1.—Unity on the c-axis may be greater or less than 1.

Note 2.—Unity on the c-axis, once determined, remains the same for all the faces on a model or crystal.

Note 3.—Prism and pinacoid faces cannot be used for determining axial ratios in this system.

Note 4.—The determination may be made more accurately by using a triangle and ruler.

II. HEXAGONAL AND TRIGONAL SYSTEMS

Orient the model over a plan of the a_1-, a_2-, and a_3-axes. Then center the oriented model over a plan of the a_2- and c-axes and plot the inclination of a face cutting these two axes.

Note 1.—In some Trigonal models the inclination of the face is difficult to project.

III. ORTHORHOMBIC SYSTEM

Proceed as under I; using, however, first a plan of the a- and b-axes to determine the relative lengths of those axes; and, second, a plan of the b- and c-axes in order to get the length of the c-axis.

Note 1.—The axial ratio must be determined *before* the indices of the forms present can be worked out.

IV. MONOCLINIC SYSTEM

Here the angle β as well as the axial ratio must be determined.

(1) Draw on cross-section paper a plan of the a- and b-axis. In this plan the a-axis, because of its slope, is *fore-shortened.* Center the model with its c-axis vertical and use the inclination of a prism face. This gives a *fore-shortened* value for unity on the a-axis which must be corrected under (3).

(2) Draw a plan of the b- and c-axes, and determine the length of the c-axis.

(3) Draw a vertical line representing the c-axis. Lay off unity on it as determined under (2). Center the model so that its plane of symmetry parallels the paper. Note the inclination of the a-axis as determined by the basal pinacoid or by the intersection of two clinodomes. Now draw in the a-axis; also draw in an axis at right angles to the c-axis, calling this the a'-axis. Lay off on the a'-axis the fore-shortened *unit length* found under (1); drop a perpendicular to the a-axis and this will intercept it at unity. The angle between the a-axis and the c-axis should be measured by a goniometer to obtain the value for β.

V. TRICLINIC SYSTEM

The axial ratios and angular values may be only very roughly approximated by graphical means. Their accurate determination is a problem in spherical trigonometry.

METHOD OF INDEXING A MINERAL COLLECTION

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The writer has increased the pleasure which he derives from mineral collecting and his knowledge of geology by following this plan of card indexing his collection. It has been found very useful in comparing of specimens and determining the correct locality when in doubt. In addition to the name and locality the following facts are indexed:

1. The name of the rock which forms the matrix of the mineral. Endeavor to name the rock as scientifically as megascopic methods will permit. If the name applied is the correct scientific one, note the fact, with source of the information. In case of metamorphism include the name of the primary rock and in case of contact metamorphism, the name of the igneous rock.

2. Type of formation—Accessory in igneous rocks, in metamorphic rocks; contact metamorphic; minerals of amygdaloidal cavities, of miarolitic cavities, of vugs or vein cavities; and so on.

3. Geological Age.

Give age of the formation and of secondary action if it has occurred. The authentic age may often be derived from publications of the U. S. Geological Survey, but if this data has not been collected in a certain region, attempt to determine the age from field work of your own or of others, quoting authority.

4. The chemical composition of mineralizers when their aid in the production of the minerals is evident.

5. Exceptionally fine specimens from the locality belonging to other collections; describe exceptional qualities.

6. Any additional features of the formation you may observe during examination.

NOTES AND NEWS

Professor G. Montague Butler has been appointed director of the Arizona State Bureau of Mines.

Owing to the rapid expansion of the work of the War Risk Insurance Bureau the entire Natural History Building of the United States National Museum has been turned over to it, and all exhibits, including the mineral collections, are now closed to the public. Research work is being continued, however, and specialists can still gain access to the study collections.

ABSTRACTS OF MINERALOGIC LITERATURE

ON THE OCCURRENCE OF ILVAITE IN THE SOUTH MOUNTAIN MINING DISTRICT, OWYHEE COUNTY, IDAHO. Earl V. Shannon. *Am. J. Sci.*, [4], **45**, (2), 118–125, 1918.

Ilvaite occurs in a contact-metamorphic deposit, associated with actinolite, garnet, epidote, pyrrhotite, chalcopyrite, sphalerite and argentiferous galena. A list of the forms observed, and a description of the properties of the mineral are given. S. G. G.

ON THE ETCHING FIGURES OF THE DIHEXAGONAL ALTERNATING TYPE. A. P. Honess. *Am. J. Sci.*, [4], **45**, (3), 201–221, 1918.

A study of the etch-figures of calcite, magnesite, siderite, rhodochrosite, and smithsonite. S. G. G.

THE OCCURRENCE OF CRISTOBALITE IN CALIFORNIA. A. F. Rogers. *Am. J. Sci.*, [4], **45**, (3), 222–226, 1918.

Cristobalite is described from two localities in California: near Tuscan Springs, Tehama Co., in distinct octahedral crystals in an auganite; and at Jamestown, Tuolumne Co., in an augite andesite, paramorphous after tridymite. S. G. G.

THE REPLACEMENT OF WOOD BY CALCITE. C. W. Greenland. *Econ. Geol.*, **13**, (2), 116–119, 1918.

Description of a complete calcification of a gymnosperm found at a point 6 miles north and 2 miles east of Russell, Kansas. S. G. G.

TESTS FOR FLUORINE AND TIN IN METEORITES WITH NOTES ON MASKELYNITE AND THE EFFECT OF DRY HEAT ON METEORIC STONES. George P. Merrill. *Proc. Nat. Acad. Sci.*, **4**, (6), 176–180, 1918.

Refined methods for the determination of fluorine were applied to the Bluff, Texas; Allegan, Mich.; and Waconda, Texas; meteorites. Altho· 10 to 20 grams of material were used in the tests, the results were negative. Analyses of schreibersite and cohenite from the Canon Diablo iron failed to show the presence of tin.

Maskelynite was found in various meteorites in all stages, from an oligoclase glass essentially isotropic, $n = 1.51$, to one plainly biaxial, but with no crystalline outlines, cleavage or other recognizable properties, with indices ranging from 1.543 to 1.56. In the isotropic form the mineral retains, in places, traces of plagioclase twinning, believed to indicate the mineral to be a re-fused feldspar, rather than a residual or original glass.

The effect of dry heat on the Estacado and Homestead stones at various temperatures is also described. S. G. G.

CONTRIBUCIONES A LA MINERALOGIA MEXICANA. ERNESTO WITTICHEN. *Memorias Y Revista Sociedad Cientifica Antonio Alizate,* **37**, (1), 23–42, 1918.

Includes descriptions and analyses of zoisite, Sierra Juarez, Lower California; rubellite, Lower California; wernerite, Ayoquesco, Oaxaca; hematite, Zacatecas; beryl, Lower California; and celestite, Amajac, Pachuca.

S. G. G.

THE GROWTH OF MINERALOGY FROM 1818 TO 1918. WILLIAM E. FORD. *Am. J. Sci.*, [4], **46**, 240–254, 1918.

This special number (of 416 pages) of the *American Journal of Science* commemorates the one-hundredth anniversary of the founding of the journal by Benjamin Silliman in July, 1818; and is devoted to a history of the various sciences during the century of its existence. On Professor Ford has devolved the writing of the history of mineralogy during this period. Mineralogy, since its beginning in America, has been inseparably bound with the Sillimans, the Danas, the *American Journal of Science* and its contributors, and Dr. Ford has presented an excellent review of the history of the science and its workers. S. G. G.

THE MELTING POINTS OF CRISTOBALITE AND TRIDYMITE. J. B. FERGUSON and H. E. MERWIN, *Am. J. Sci.*, [4], **46**,(8), 417–426, 1918.

A new type of furnace is described in which the following melting points were determined: cristobalite, 1710° ± 10° C.; and tridymite, 1670° ± 10°. Quartz was directly inverted into tridymite by dry heat alone. S. G. G.

GEMS AND PRECIOUS STONES IN 1916. WALDEMAR T. SCHALLER U. S. Geol. Survey, *Mineral Resources* U. S., **1916**, II, 887–899, 1918.

Besides giving statistics of production, the writer briefly notes the occurrence of the gem minerals in the various states. An exhibit of tourmaline, beryl, kunzite, and the associated minerals of the pegmatites of Southern California in the U. S. National Museum is described in detail. S. G. G.

NOTE ON THE STRATHMORE METEORITE OF 1917, DEC. 3. R. A. SAMPSON. *Proc. Roy. Soc. Edinburgh*, **38**, I, 70–74, 1918.

Note of a stone that fell in S. E. Scotland, on December 3, 1917. A number of fragments were recovered, the largest weighing 22.5 lbs. Details of the fall are described, with speculative data as to the flight and origin of meteorites. S. G. G.

NOTES ON THE POSSIBLE ORIGIN OF THE MAGNESITE NEAR VALLEY, WASHINGTON. OLAF P. JENKINS. *Econ. Geol.*, **13**, (5), 381–384, 1918.

Large deposits of coarsely crystalline pink to dark gray magnesite occur about 50 miles north of Spokane, interbedded with dolomites and other sedimentary rocks. The magnesite is believed to have been formed from the dolomitic or limestone beds by the replacement of Ca by Mg effected by circulating underground waters. S. G. G.

RECENT ADVANCES IN MINERALOGY AND CRYSTALLOGRAPHY. A. Scott. *Science Progress*, **49**, 38–43, July, 1918.

NOTEWORTHY CRYSTALS OF FLUORITE FROM THE BAVENO GRANITE. Fausta Balzac. *Atti accad. sci. Torino*, **52**, 1014–1020, 1917; thru *Chem. Abstr.*, **12**, 126, 1918.

Five crystals are described, one of them being shown by its deep blue-violet color and high refractive index and specific gravity to be a sort of yttrofluorite.

E. T. W.

A THEORY OF CRYSTAL STRUCTURE WITH APPLICATION TO TWENTY CRYSTALS BELONGING TO THE CUBIC SYSTEM. Albert C. Crehore. *Phys. Rev.*, **10**, 432–460, 1917.

A mathematical discussion of the forces acting upon atoms and electrons arranged according to the various cubic space-lattices, as exemplified by the cubic minerals which have been studied by X-rays. E. T. W.

STUDIES IN THE CALCITE GROUP. William E. Ford. Yale Univ. *Trans. Conn. Acad. Arts Sci.*, **22**, 211–248, 1917.

The structure, molecular volumes, and refractive indices of the minerals of the calcite group are discussed, and the relations between the several members pointed out. By allowing for volume changes, the specific gravities and indices of the pure carbonates can be calculated from those measured on natural isomorphous mixtures, and conversely the composition of a mixture from its physical properties. E. T. W.

MIXED CRYSTALS. Carlo Viola. *Atti accad. Lincei*, **26**, I, 195–207, 1917; thru *Chem. Abstr.*, **12**, 329, 1918.

A discussion of mixed crystals from the point of view of the capillary constants of faces, reticular density, etc. It is concluded that there is no essential difference between isomorphous mixtures and solid solutions, the members of a series exerting mutual influence on molecular volumes, etc., in either case.

E. T. W.

THE FORMATION OF TWIN CRYSTALS. Carlo Viola. *Atti accad. Lincei*, **26**, I, 278–286, 1917; thru *Chem. Abstr.*, **12**, 330, 1918.

A mathematical discussion of twinning. E. T. W.

THE ORIGIN OF CHERT IN THE BURLINGTON LIMESTONE. W. A. Tarr. *Am. J. Sci.*, [4], **44**, 409–452, 1917.

From an elaborate study of the chert and its occurrence it is concluded that the silica was originally precipitated in colloidal form on the sea bottom, contemporaneously with the limestone, and subsequently consolidated. The theory of origin by replacement of the rock subsequent to its consolidation is believed to be untenable. E. T. W.